Orbiter Middeck Payload Provisions Handbook

Orbiter Middeck

Payload Provisions

Handbook

Prepared by: _____
SP33/Marion W. Hix

Approved by: _____
SP33/William A. Langdoc
Head Crew Station Integration Section

Approved by: _____
SP/Chris D. Perner
Chief, Crew Station Branch

Approved by: _____
LN/Larry Bell
Manager, Integration Engineering Office

PL:PROV/FM/HB
3/26/84

PREFACE

This handbook describes standard locker and special stowage provisions for payloads that are to be accommodated in the Orbiter middeck. This information is provided to assist potential users in designing payload hardware that can be readily integrated. This is not a controlled document; therefore, it is not intended to replace existing Space Transportation System (STS) program documentation containing detailed engineering data.

Approval to use Orbiter Middeck payload accommodations may be obtained by submitting STS Form 100, Request for Flight Assignment. It should be addressed to:

Space Transportation System Operations
Mail Code MO
National Aeronautics and Space Administration
Washington, DC 20546

Approved payloads will be integrated in accordance with an STS Payload Integration Plan (PIP). The PIP and applicable annexes define agreements between the STS and the payload supplier and identify respective task responsibilities. Details concerning the PIP process are available from the Mission Integration Office of the Space Shuttle Program Office (SSPO) at the Lyndon B. Johnson Space Center (JSC) Houston, Texas.

In addition to JSC/SSPO and Payload Project Engineers, the members of the Crew Station Integration Section (JSC/SP33) are also available to assist the designer in integrating approved payload hardware into the Orbiter middeck to assure optimum equipment performance and mission success.

Contents

Figures

TABLES

1.0 INTRODUCTION

This handbook describes stowage provisions for experiments or payloads that can be accommodated in the Shuttle Orbiter Crew Compartment Middeck.

Standard stowage lockers are available with modified doors to accommodate experiments requiring Orbiter power and/or crew attendance.

Special adapter plates are available for experiments or payloads that cannot be fitted in a standard stowage locker.

Also delineated in this handbook is supporting hardware to assist the user in experiment design and ground handling.

2.0 STANDARD STOWAGE PROVISIONS

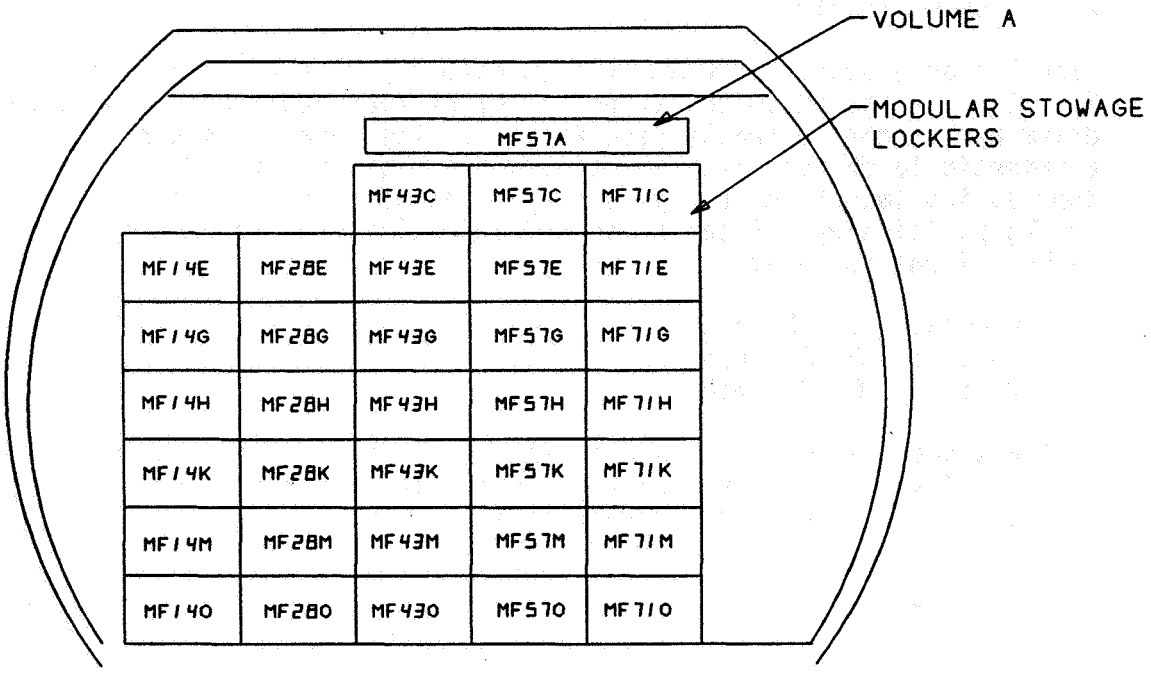
Space is available in the Orbiter middeck area for 42 standard stowage lockers (see fig. 1). Unassigned lockers, not used for flight crew equipment (food, clothing, etc.), may be made available for payload usage. These standard lockers can be used with or without trays. Two standard sizes of reusable trays are available. Foam inserts can be placed in the trays to cushion the stowed items. Inside locker dimensions are shown in figure 2.

Foam cushions with intricate cutouts can be inserted in the trays to retain and cushion fragile equipment, or tray dividers can be installed in an egg crate configuration for equipment separation. The dividers are held in place by plastic buttons, which in turn fit into patterns of holes drilled in both large and small trays. The egg crate configuration can divide the tray into halves, quarters, eighths, or sixteenths.

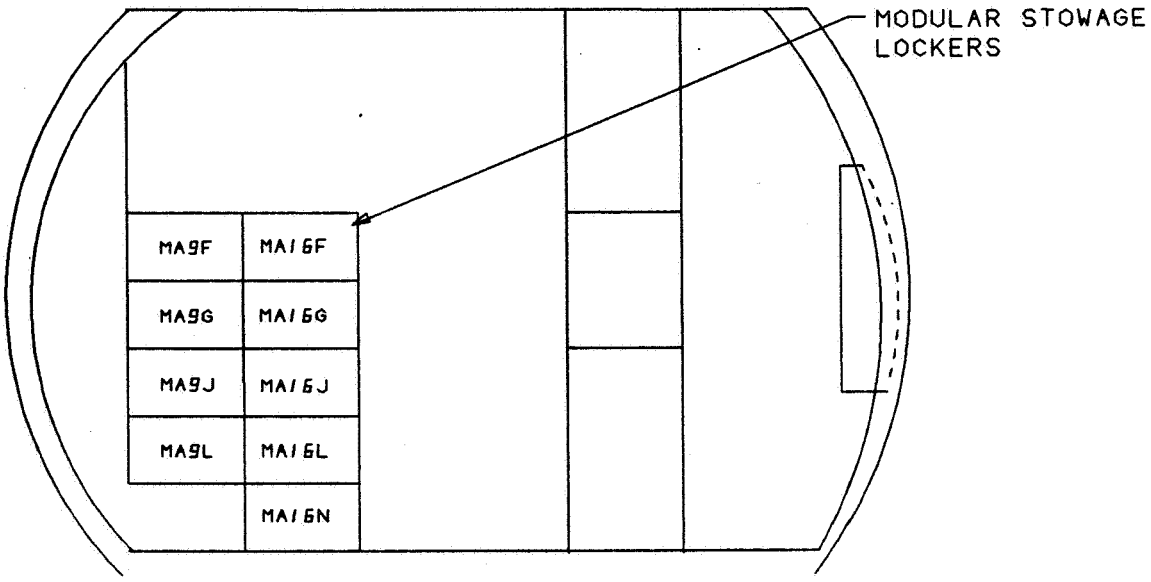
Elastic restraints can be used with or without the dividers. These restraints, located in the trays, will prevent equipment from floating out when the lockers are opened in orbit.

Both large and small trays can be packed, transported to the Orbiter launch pad, and installed in lockers normally as late as five days before launch. To accomplish this, however, the flight hardware must be delivered approximately one month before flight.

In unique situations where long prelaunch stowage periods will cause deterioration of the experiment, a time frame may be available late in the countdown for installation. However, in these situations the user could be responsible for the resulting launch impact costs.



MIDDECK (LOOKING FWD)



MIDDECK (LOOKING AFT)

Figure 1.- Middeck modular stowage locker configuration.

2.1 STOWAGE LOCKER

Each locker provides 2 cubic feet (0.0566 m^3) of stowage volume (see fig. 2). It is attached to the avionics bay by four fasteners using an extension drive and ratchet assembly (see fig. 3). The locker has a hinged door with a magnetic latch for on-orbit use and two captive latches for securing the door during launch and entry/landing. The door has a friction hinge for zero-g positioning; it can be opened approximately 180 degrees. The outside locker dimensions are:

Length: 21.062 inches
Height: 10.757 inches
Width: 18.125 inches

Payloads that cannot be stowed inside trays may be stowed directly in a locker. However, the payload must be isolated from vibration contact with the locker and have zero g retention if on-orbit activities are required.

The maximum weight of the locker contents, including hardware, protective provisions and trays, must not exceed 60 pounds to prevent overloading of the support structure. Locker weight is given in ICD-2-1M001.

The center of gravity (c.g.) for a packed locker shall not exceed 14 inches in the X-direction from the locker attach face. The Y and Z locations of the c.g. shall be within a two-inch radius of the geometric center.

The locker drawing number is V602-660604-001.

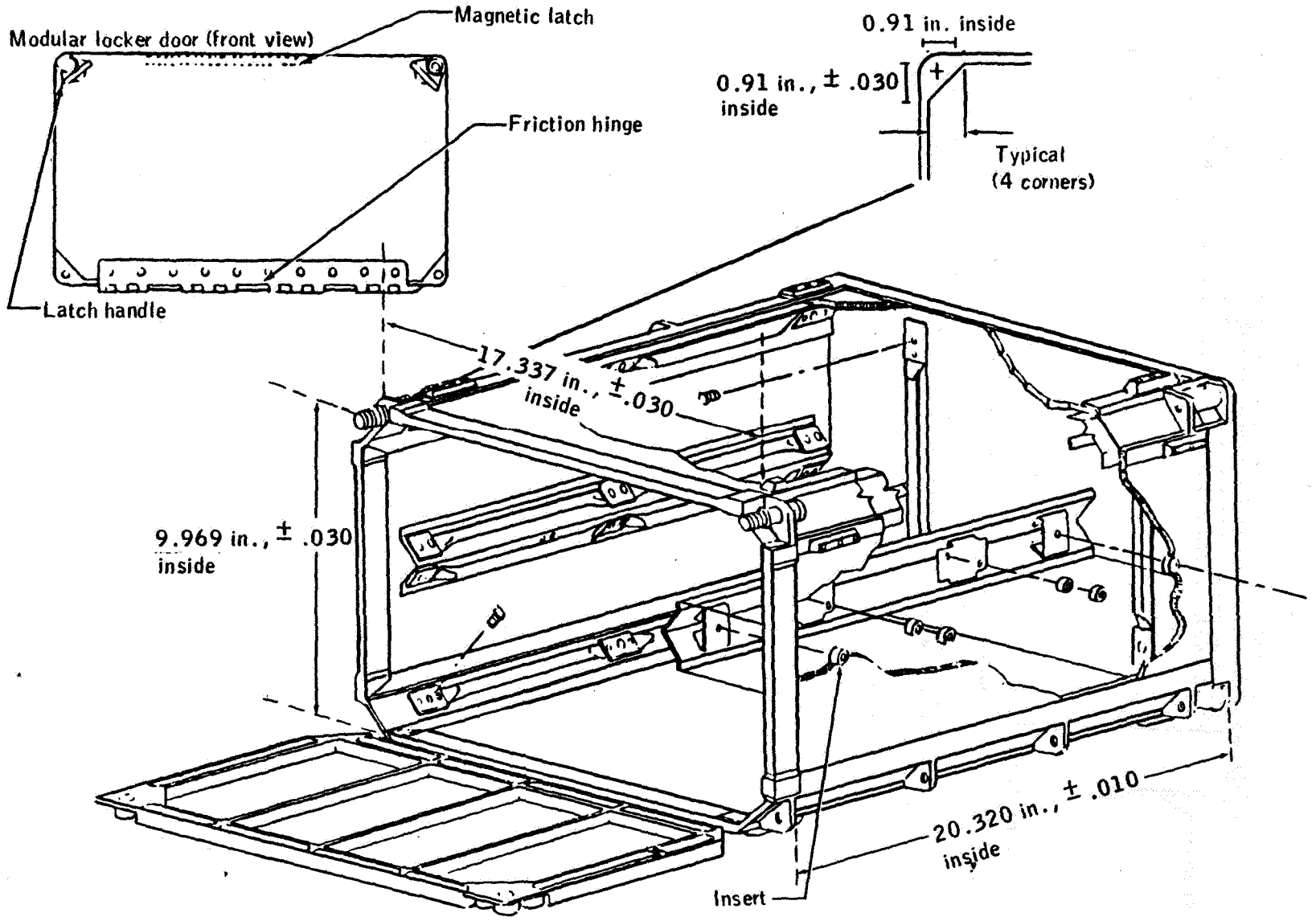


Figure 2.- Middeck modular locker.

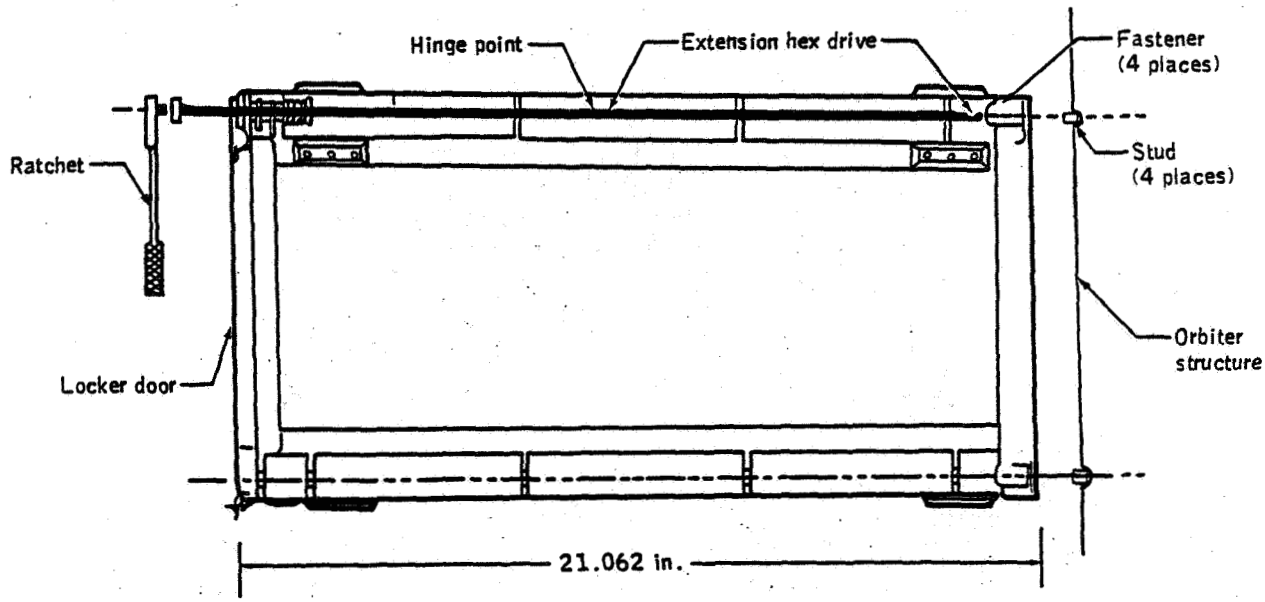
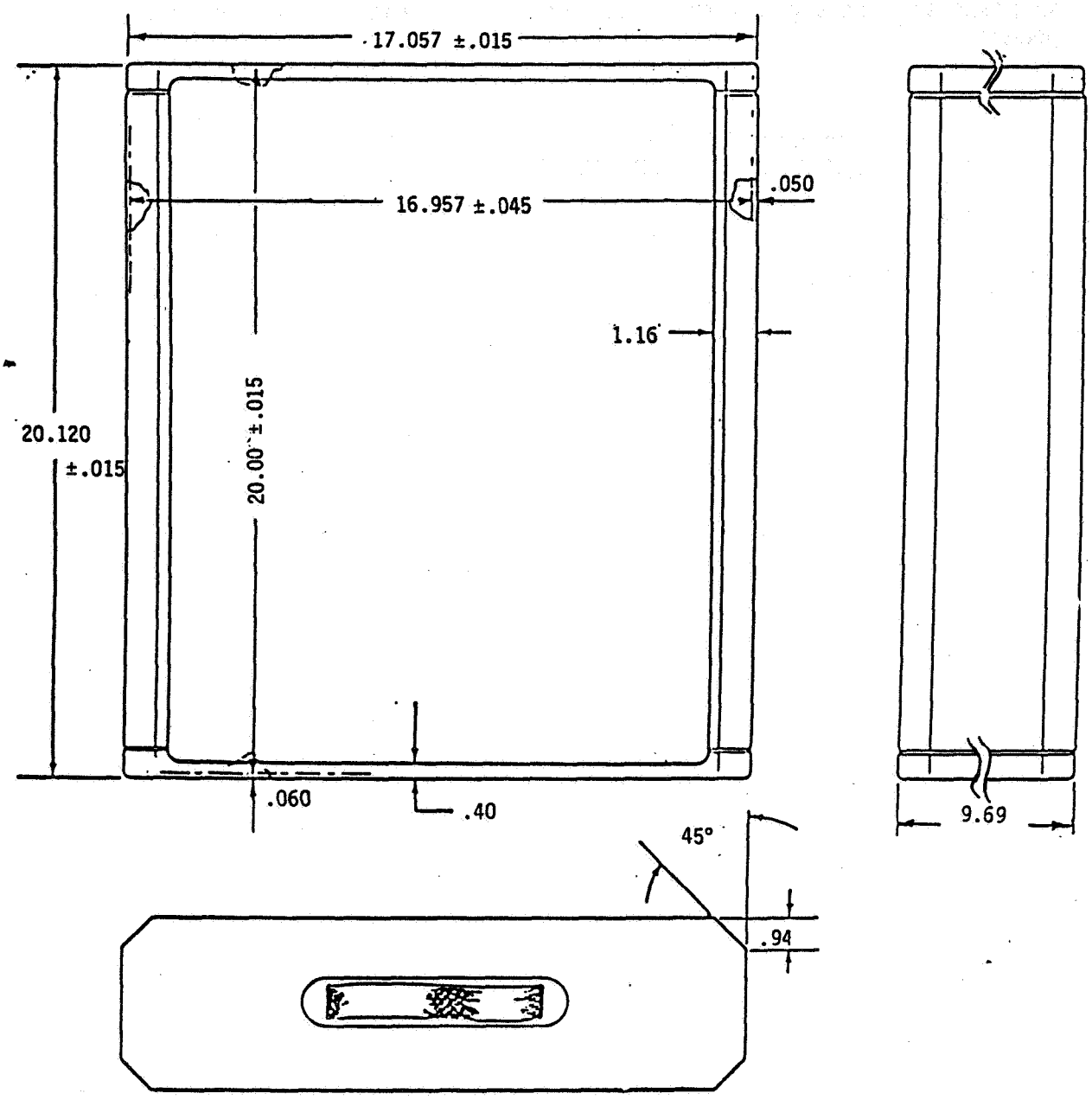


Figure 3.- Modular locker installation/removal.

PL:PROV/HB
3/8/84

2.2 LARGE TRAY

The large trays are pressure formed from plastic. The tray volume is 1.8 cubic feet (0.05 m^3) and the dimensions are as shown in figure 4. Large tray weight is approximately 3.4 pounds.



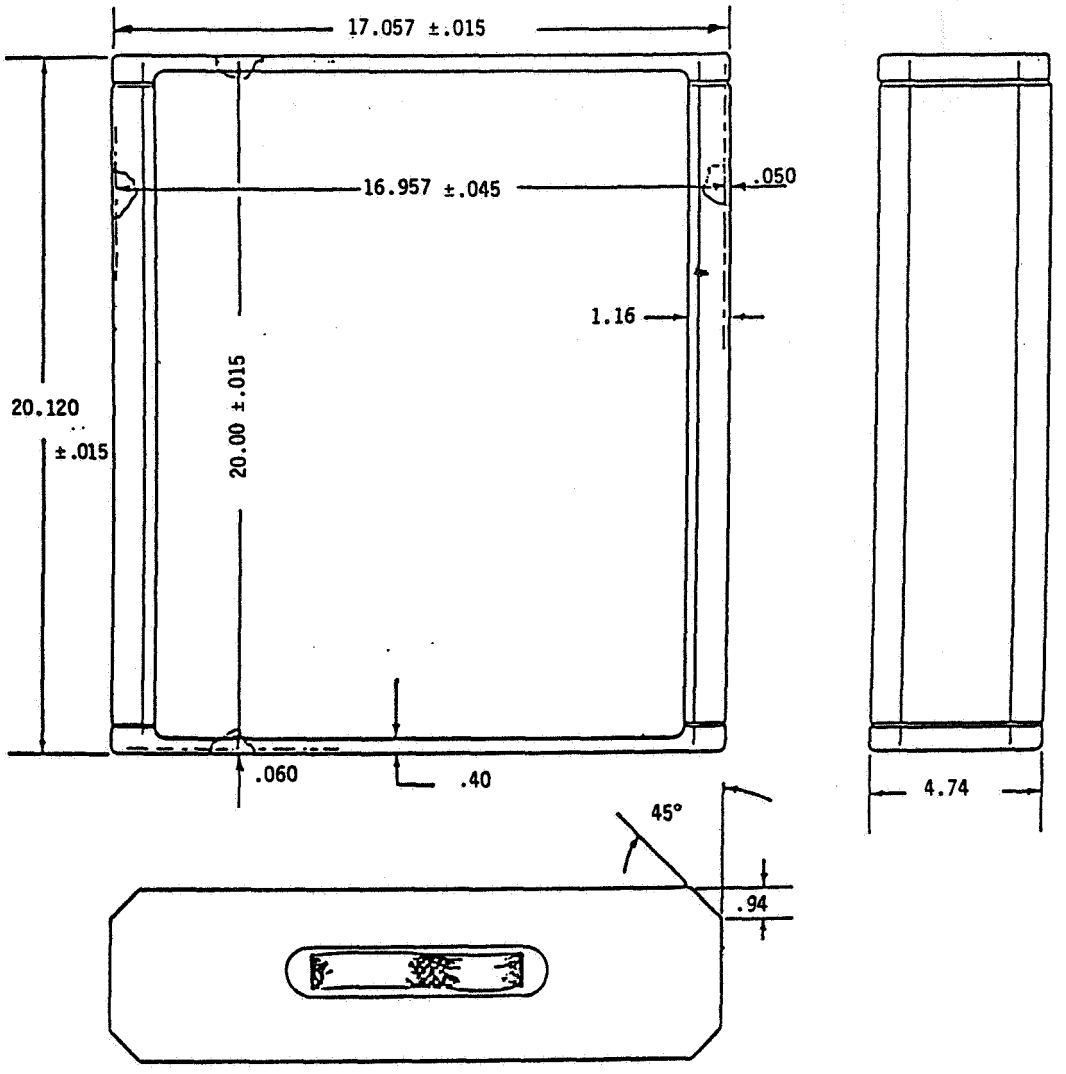
(All dimensions are in inches)

Figure 4.- Large stowage tray.

PL:PROV/HB
3/26/84

2.3 SMALL TRAY

The small trays are identical to the large trays except for the height (see fig. 5). This height reduces the stowage volume of the tray to 0.85 cubic feet (0.02 m^3). Two small trays can be stowed in one standard stowage locker. Separation of the small trays in the locker is accomplished by installing special guides, containing friction devices, on the locker sides. This feature allows each small tray to be removed individually, yet remain in place in a zero-g environment. Small tray weight is approximately 2.45 pounds.



(All dimensions are in inches)

Figure 5.- Small stowage tray.

PL:PROV/HB
3/26/84

2.4 VOLUME A

A stowage volume located above the forward middeck lockers, which is not normally removed from the middeck, is available for experiment stowage. The volume will accommodate three single stowage trays with guides side by side or a clear volume of 5.184 inches high by 20.315 inches deep by 52.02 inches wide with the tray guides removed. See figure 6. A door with three (3) removable panels encloses the volume. Any of the panels can be removed without affecting its structural integrity.

Payloads that cannot be stowed inside small trays may be stowed directly in Volume A. However, the payload must be isolated from vibration contact with the locker and have zero g retention if on-orbit activities are required.

The maximum weight of the locker contents, including hardware, protective provisions and trays, must not exceed 95 pounds to prevent overloading of the support structure.

The c.g. as with any other packed locker, shall not exceed 14 inches in the X-direction from the back of the locker.

The locker drawing number is V603-660760-001.

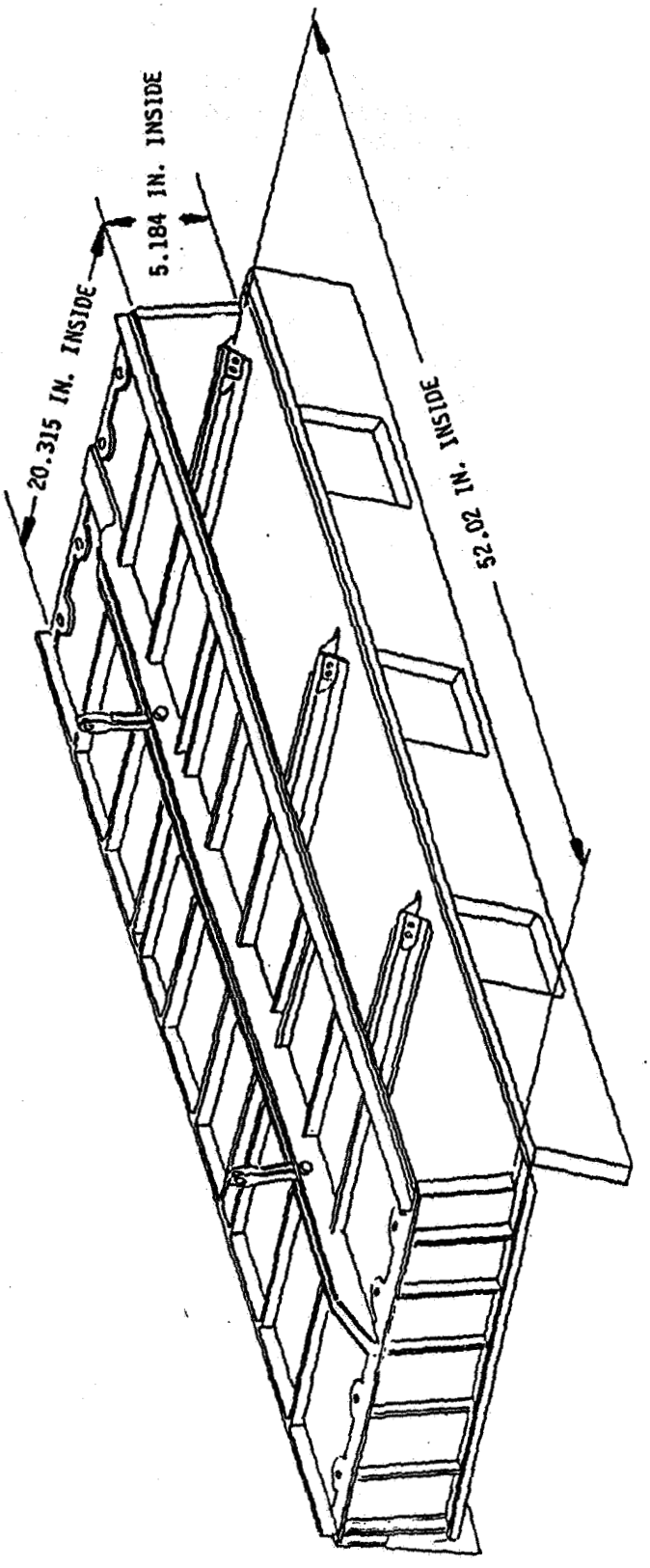


Figure 6.- Volume A.

PL:PROV/HB
3/8/84

3.0 SPECIAL STOWAGE PROVISIONS

In addition to the standard complement of stowage provisions, the STS is providing an inventory of provisions called the Middeck Payload Accommodation Kit (MPAK) which currently consists of single and double adapter plates, payload mounting panel, modified locker doors, power cables, connectors and ground support fittings to handle heavy experiments.

3.1 SINGLE ADAPTER PLATE

The single adapter plate may be used instead of the standard modular locker. The plate has a universal hole pattern for attaching experiments or payloads directly to the plate as depicted in figure 7. The single adapter plate hole pattern is shown in figure 8. The single adapter plate drawing number is V733-660310.

It should be noted that the total suspended weight includes the weight of the single adapter plate and the hardware. The weight of the single adapter plate is 6.2 pounds and its thickness is .75 inch. The c.g. in the X-direction is measured from the avionics bay structure reference plane as shown in table I. The single adapter plate is provided with its own capture bolts for attachment to the wall fittings. The added holes in the pattern will accommodate 1/4-28 bolts for hardware mounting. Payloads that are mounted on the single adapter plate must allow clearance for the locker tool to engage the capture bolts.

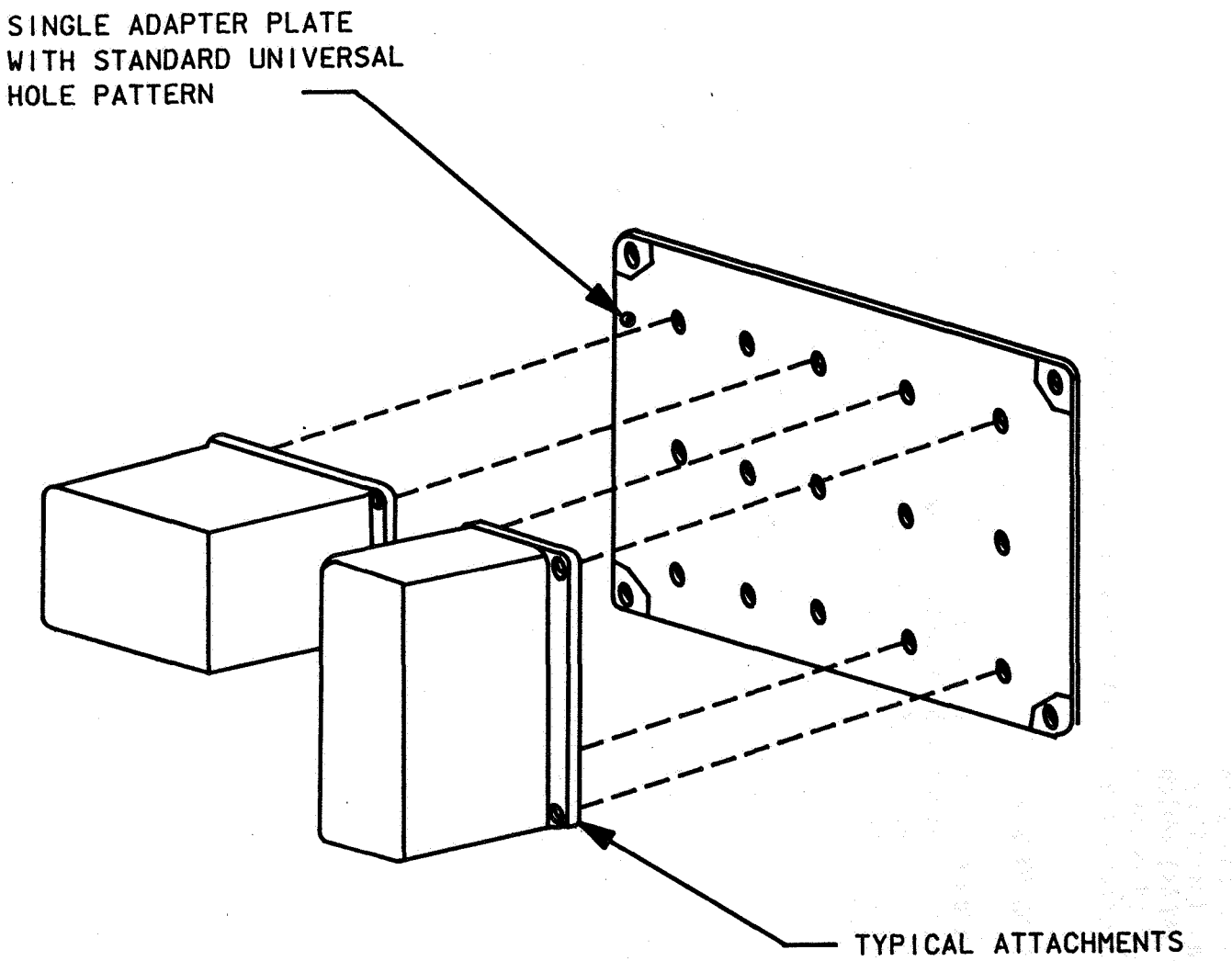


Figure 7.- Stowage and mounting provisions - single adapter plate.

PL:PROV/HB
3/26/84

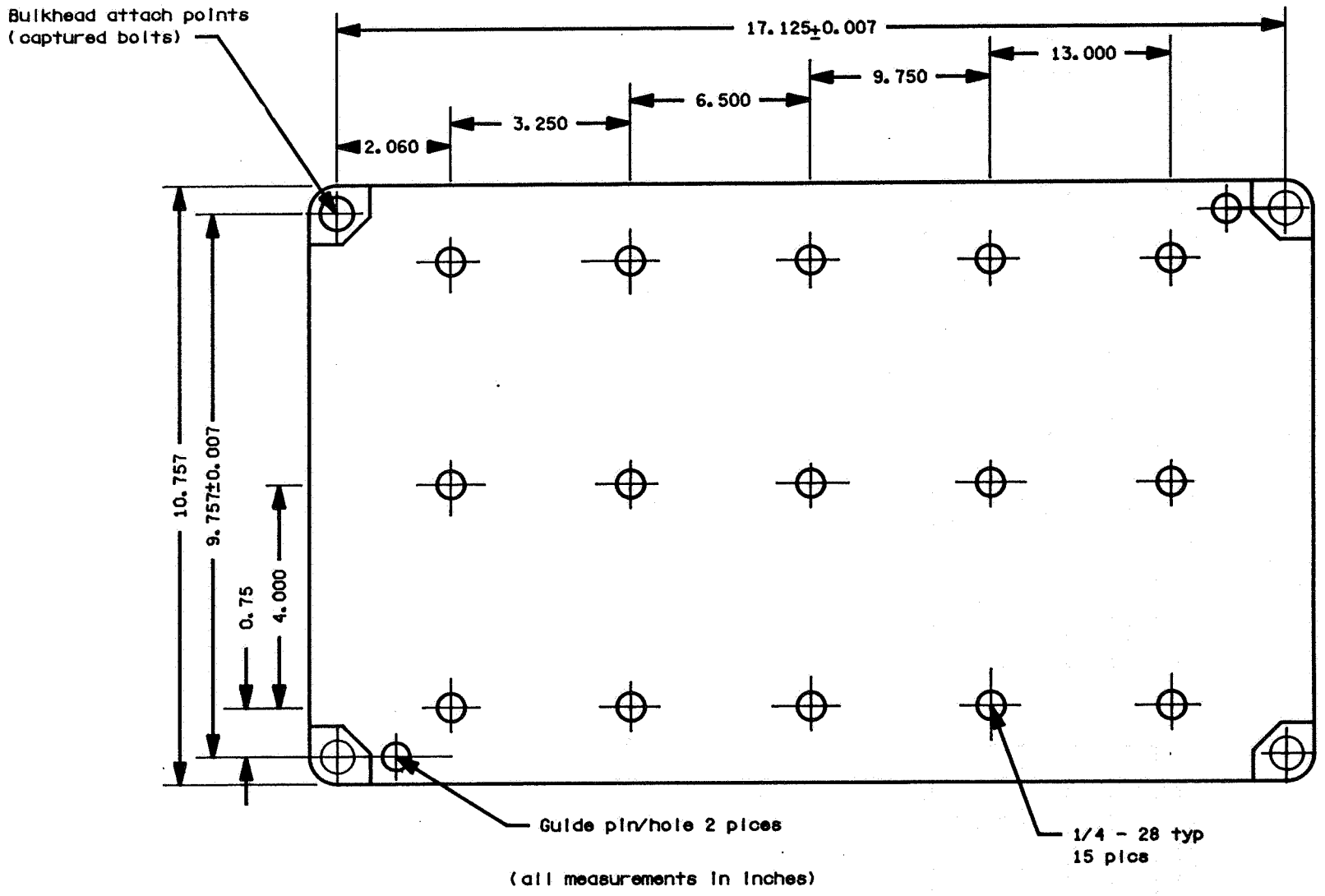
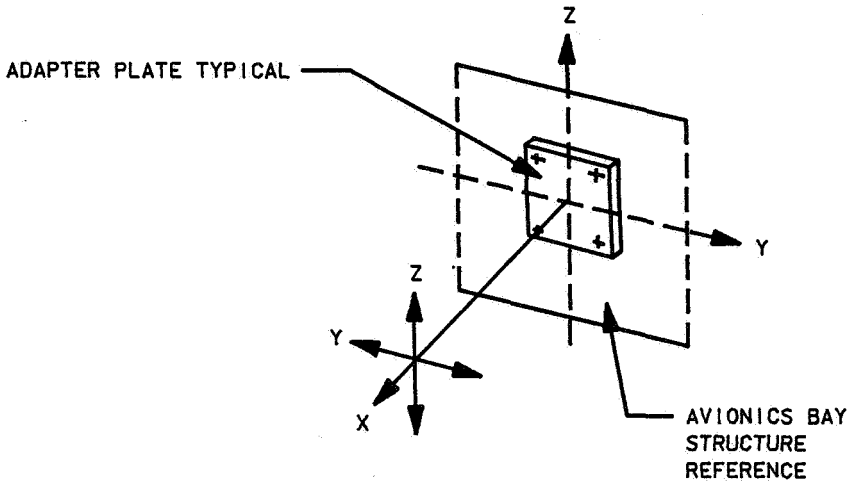


Figure 8.- Middeck payload accommodation kit - single adapter plate.

TABLE I.- MAXIMUM SUSPENDED WEIGHT AND CENTER OF GRAVITY FOR LOADED SINGLE ADAPTER PLATE

Center of plate		±3 Inch Y		±3 Inch Z	
c.g. (In.) X	Wt. (lb)	c.g. (In.) X	Wt. (lb)	c.g. (In.) X	Wt. (lb)
14	51	14	37	14	31
13	55	13	40	13	34
12	59	12	44	12	37
11	65	11	48	11	40
10	69	10	52	10	44

(Please refer to ICD-2-1M001 for current weight/c.g. parameters.)



3346.ART, 1

PL:PROV/HB
3/26/84

3.2 DOUBLE ADAPTER PLATE

In certain cases where an experiment cannot be mounted on a single adapter plate or the experiment exceeds 2 cubic feet, a double adapter plate can be used, as depicted in figure 9. Its universal hole pattern for attaching the experiment is shown in figure 10.

The double adapter plate drawing number is V733-660311. The single adapter plates must be installed one above the other to the locker interface. The double plate can be secured to these single plates, as shown in figure 11. It should be noted, however, that the total suspended weight includes the weight of the two single plates plus one double adapter plate. See conditions 1, 2, and 3 of table II for the total load-carrying capability and maximum c.g. for given conditions. The installed experiment should not extend beyond the locker door plane.

The double adapter plate weighs 12.5 pounds and is 0.875 inch thick. Special bolts are provided to attach the double plate to the single plates. Payloads that are mounted on the double adapter plate must allow clearance for the locker tool to engage these bolts. The hardware supplier should use the 1/4-28 bolts with a 3/16 inch socket head to attach hardware to the double adapter plate. This will aid in-flight maintenance, if required, by allowing the use of existing onboard tools.

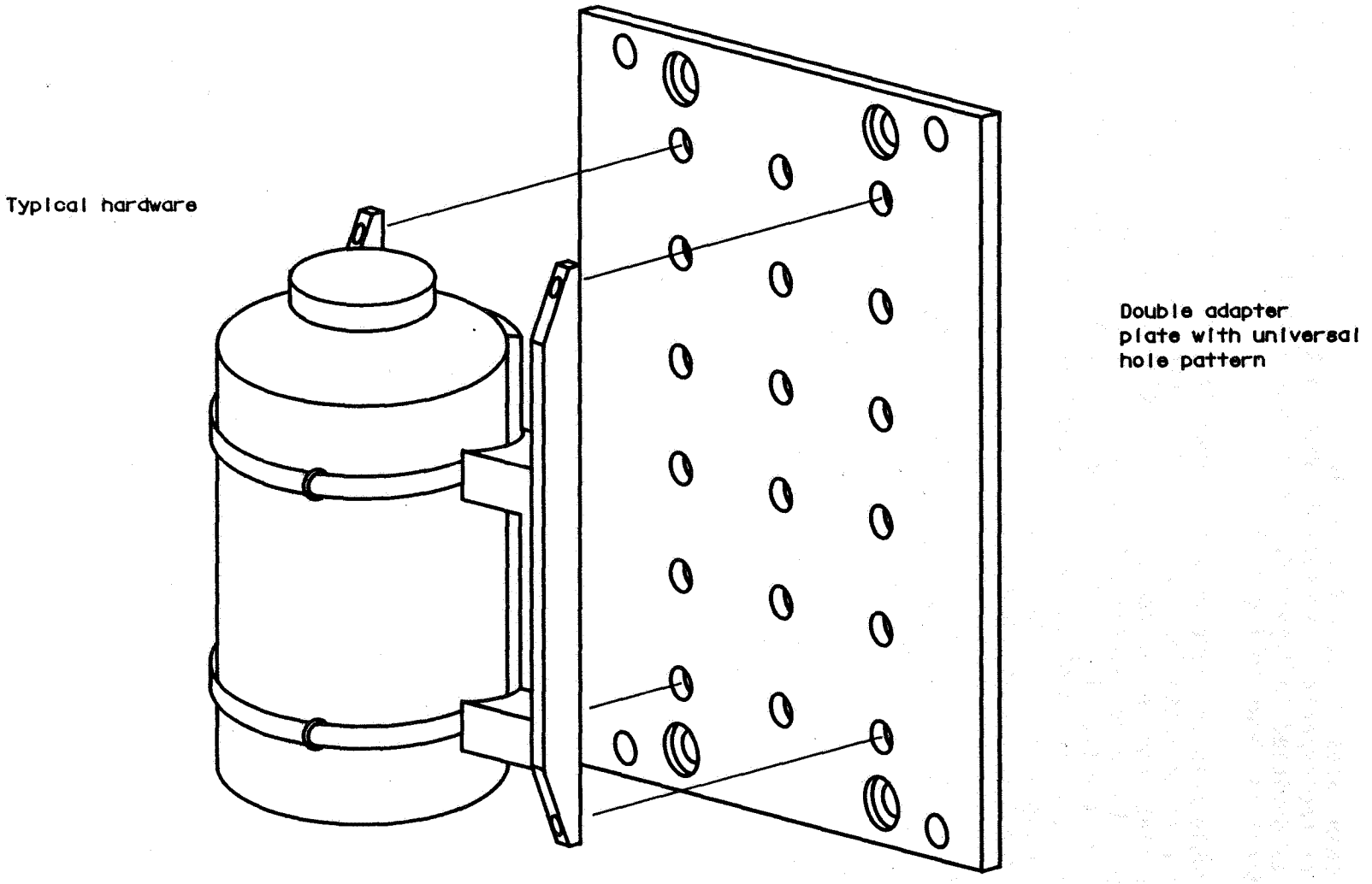


Figure 9.- Stowage and mounting provisions - double adapter plate.

3349. ART. 1

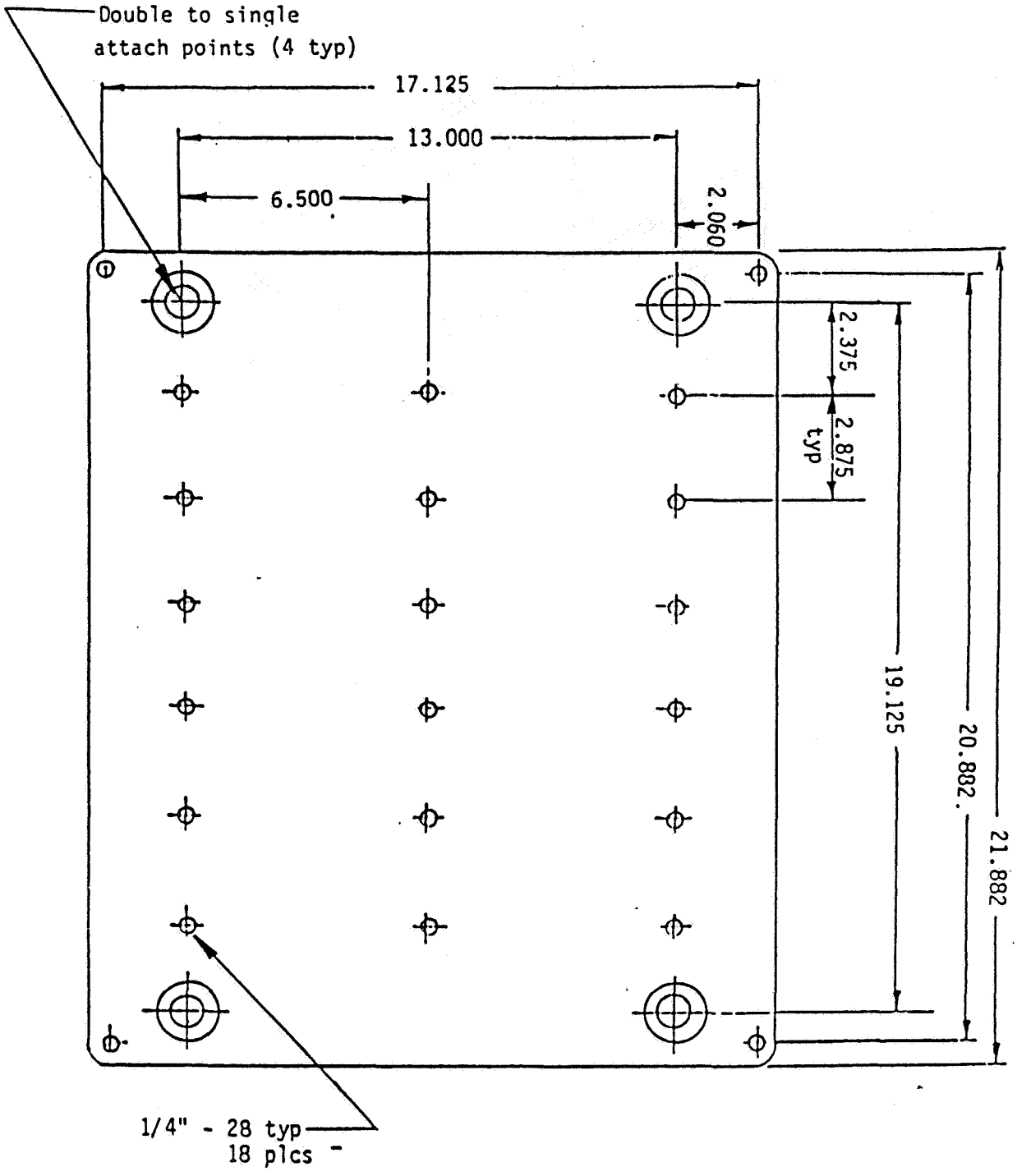


Figure 10.- Middeck Payload Accommodation Kit - double adapter plate.

PL:PROV/HB
3/26/84

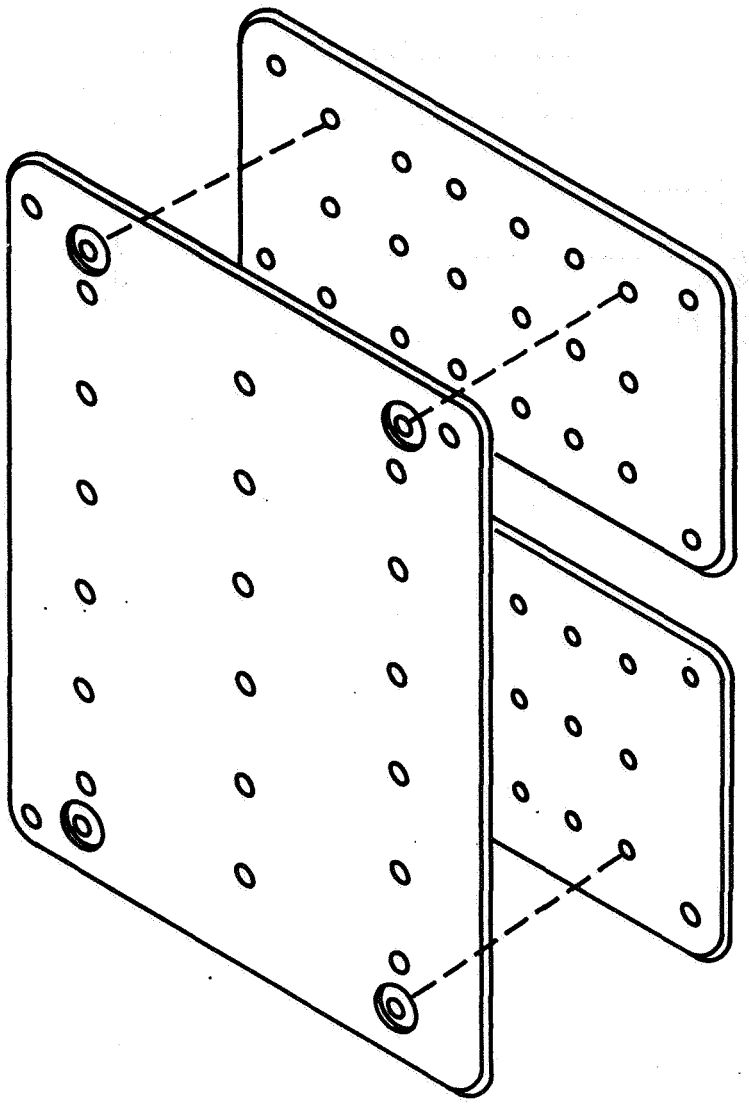


Figure 11.- Mounting provisions for double adapter plate.

3350. ART. 1

TABLE II.- MAXIMUM SUSPENDED WEIGHT AND C.G. FOR DOUBLE ADAPTER PLATE.

(Please refer to ICD-2-1M001 for current weight/c.g. parameters.)

CONDITION 1 DOUBLE PLATE PAYLOAD - CONCENTRIC LOAD

CENTER OF GRAVITY (INCHES)	TOTAL WEIGHT (POUNDS)
14 MAXIMUM	120 MAXIMUM

CONDITION 2 DOUBLE PLATE PAYLOAD - ECCENTRIC LOAD CONDITION ±3 IN. ALONG Y-AXIS

CENTER OF GRAVITY (INCHES)	TOTAL WEIGHT (POUNDS)
14 MAXIMUM	88
13	94
12	102
11	112
10	120 MAXIMUM

CONDITION 3 DOUBLE PLATE PAYLOAD - ECCENTRIC LOAD CONDITION ±3 IN. ALONG Z-AXIS

CENTER OF GRAVITY (INCHES)	TOTAL WEIGHT (POUNDS)
14 MAXIMUM	87
13	94
12	101
11	110
10	120 MAXIMUM

3.3 PAYLOAD MOUNTING PANEL

The payload mounting panel (PMP) design allows a two-locker size payload to be directly mounted to the two PMP's which mount to the wire trays, thus eliminating the need for a double adapter plate. The weight of the PMP is 3.4 pounds each. The mounting bolt holes of the payload must be 0.312 inch in diameter to allow for a +0.030 inch installation tolerance between the two PMP's. Payload base plate thickness must be 0.25 inch. Basic dimensions for the attach points are shown in figures 12 and 13. The alternate set of attach points may be used also. Bolts and washers required to attach payloads to the PMP will be supplied by the STS.

It should be noted that the total payload suspended weight includes the weight of the PMP and conditions in table II apply.

The PMP drawing number is ILC 10108-10077-01.

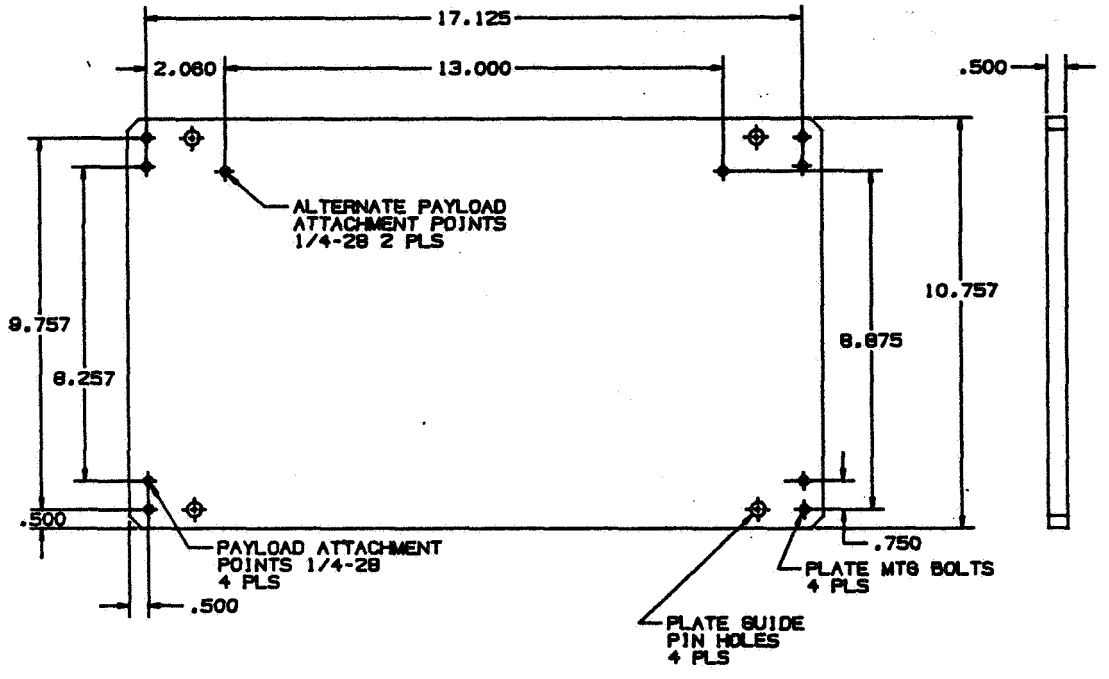


Figure 12.- Payload mounting panel.

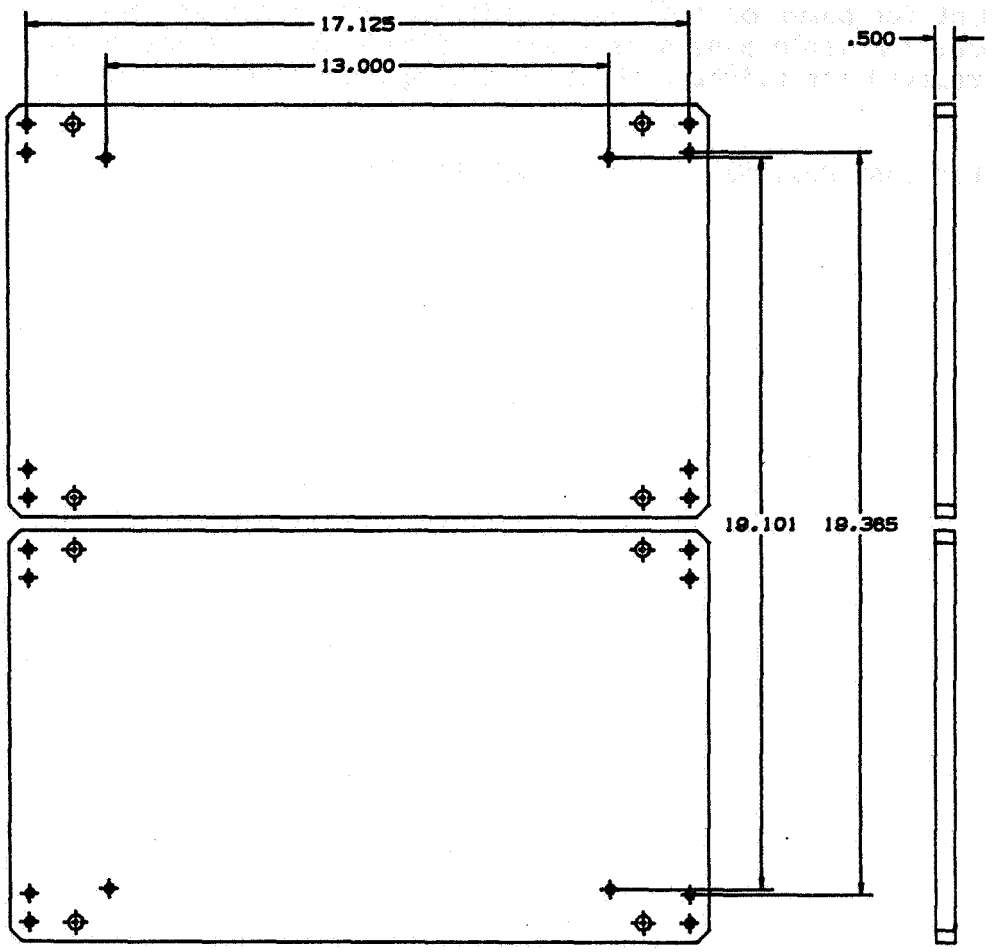
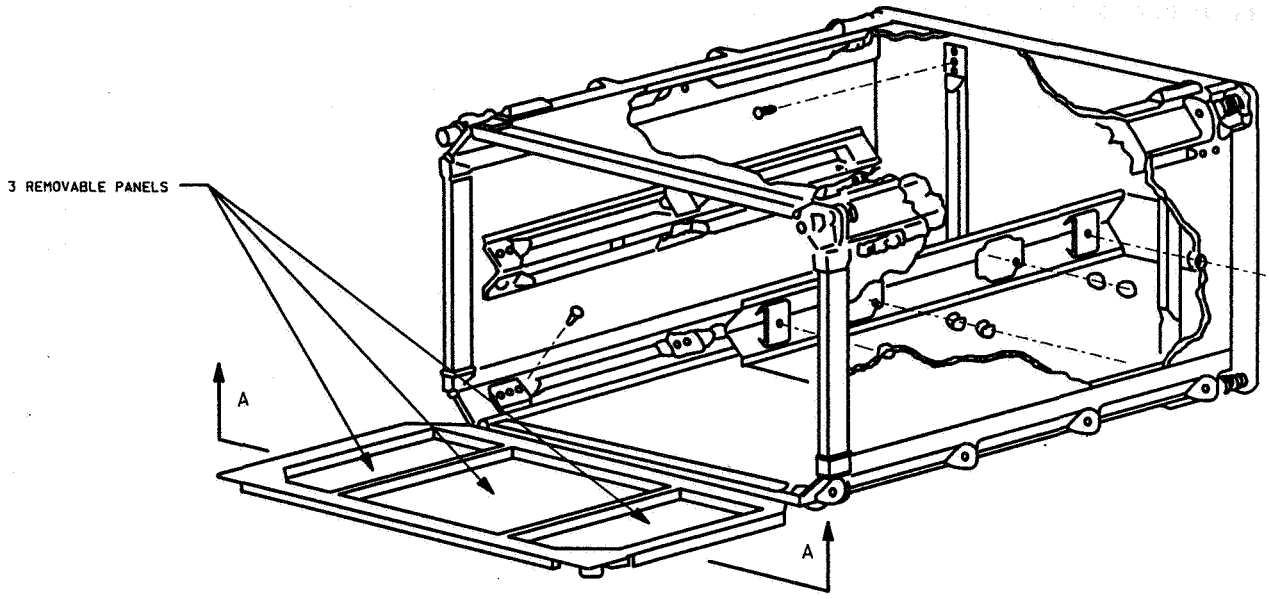


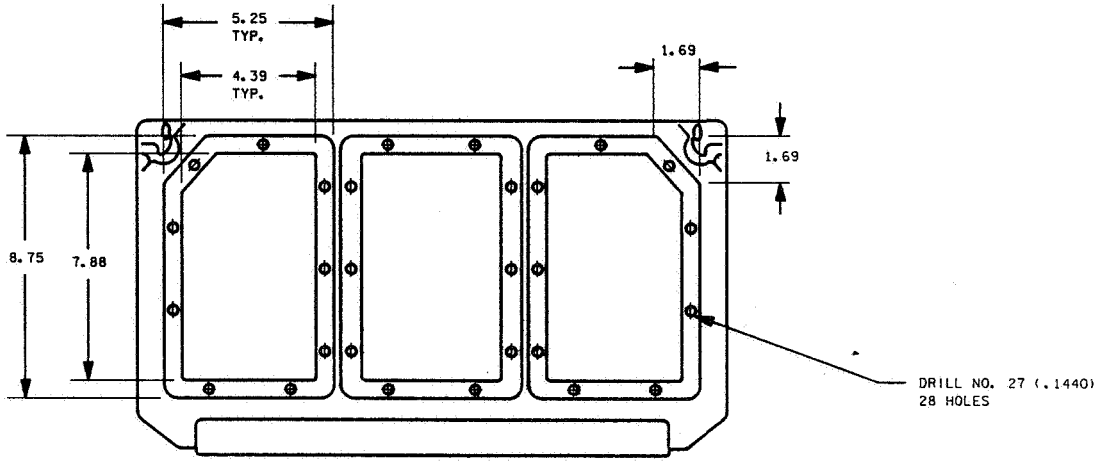
Figure 13.- Payload mounting panel installation.

3.4 MODIFIED LOCKER DOOR

When the user can use a standard stowage locker but needs access to the experiment for power or cooling, a modified locker access door is available with three removable panels as shown in figure 14. Any one or all panels may be removed for flight without affecting the structural integrity of the locker.

The locker door drawing number is V733-660313.





PANEL CONFIGURATION A-A
(ALL DIMENSIONS IN INCHES)

3352.ART.1

Figure 14.- Modified locker access door.

PL:PROV/HB
3/26/84

3.5 POWER PROVISIONS

The Orbiter provides both 28 V DC (up to 10 amps) and 115 V AC (400 Hz, three-phase, up to 3 amps per phase) power in the middeck. This power can be made available for payload use depending on mission phase and other demand. Typical power provisions and cable routing to the experiment hardware are shown in figures 15, 16, and 17.

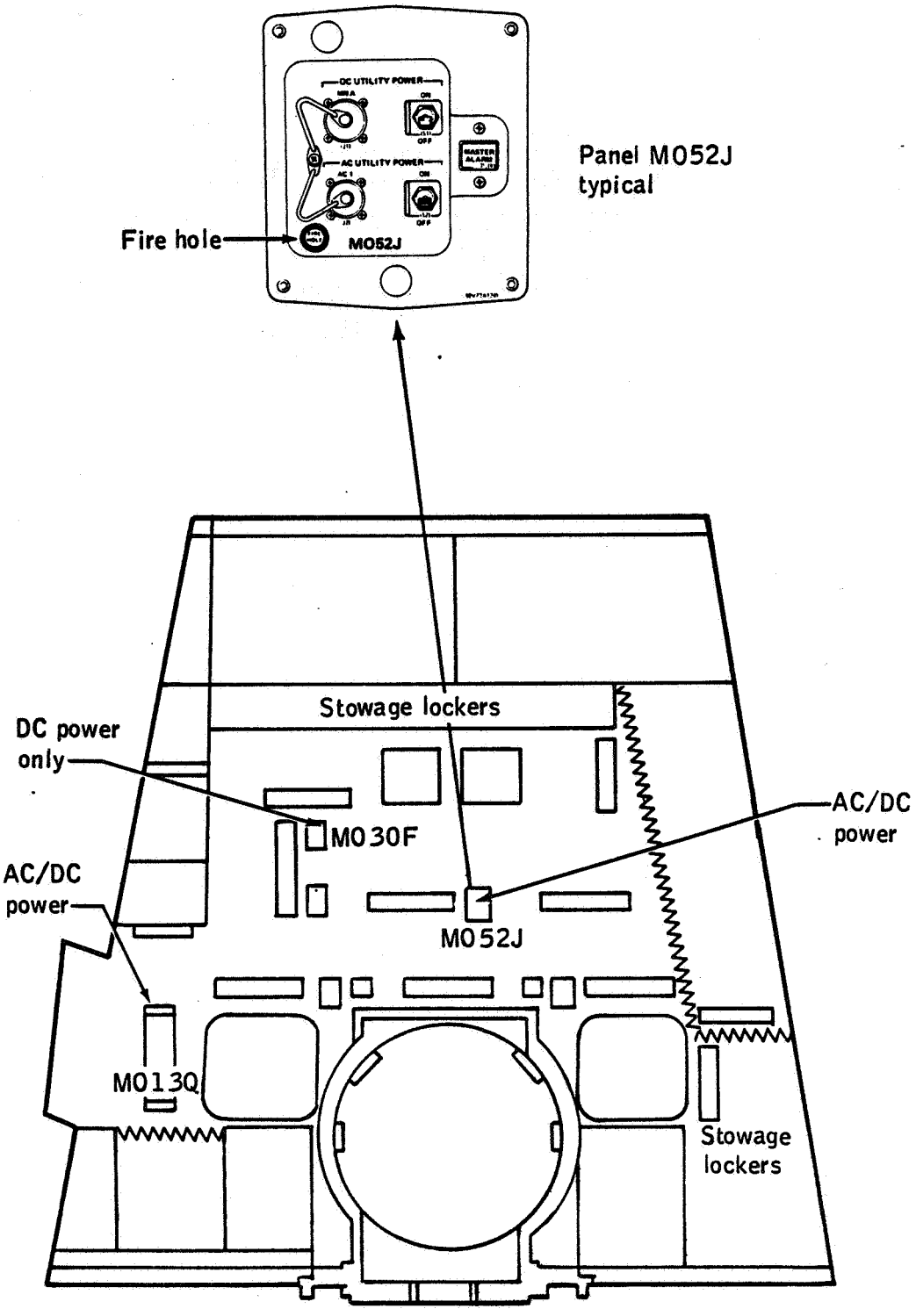


Figure 15.- Power provisions.

PL:PROV/HB
3/26/84

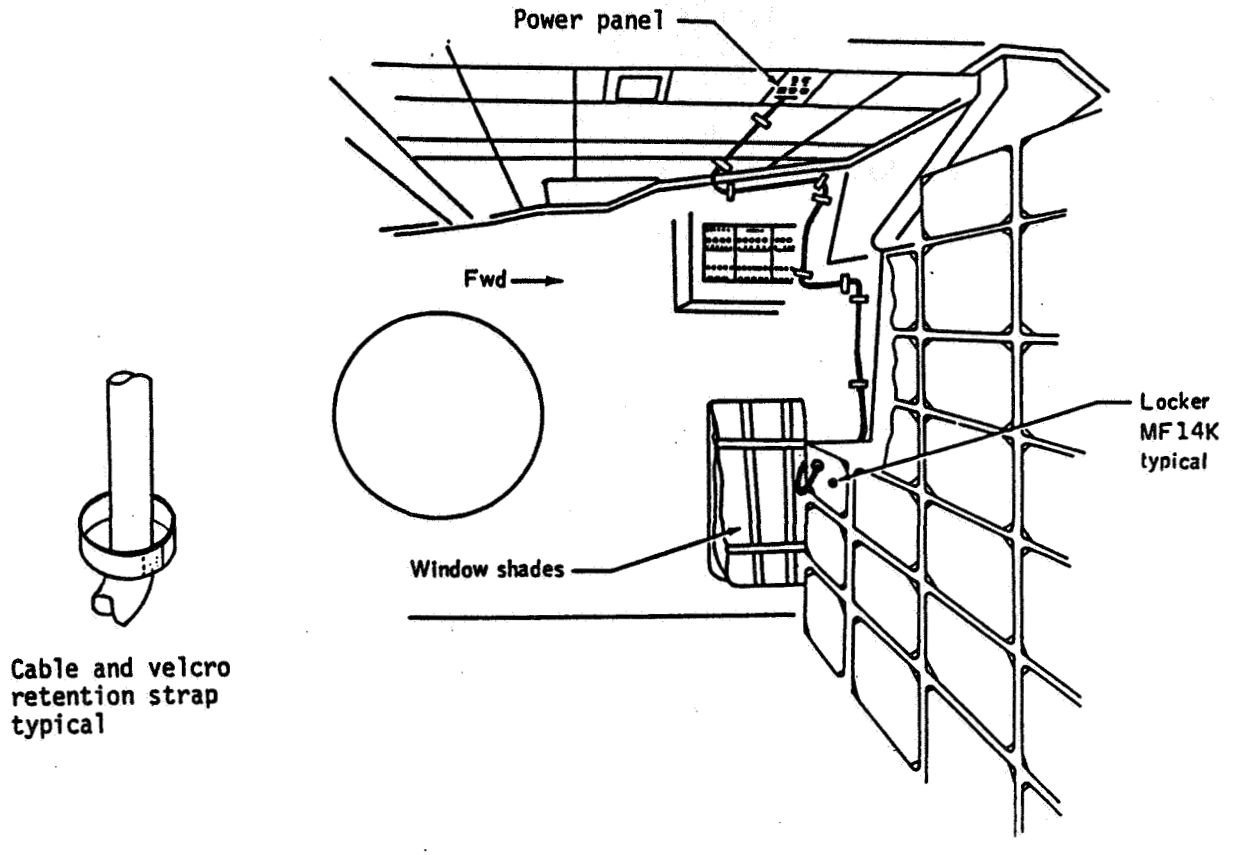


Figure 16.- Typical middeck cable routing.

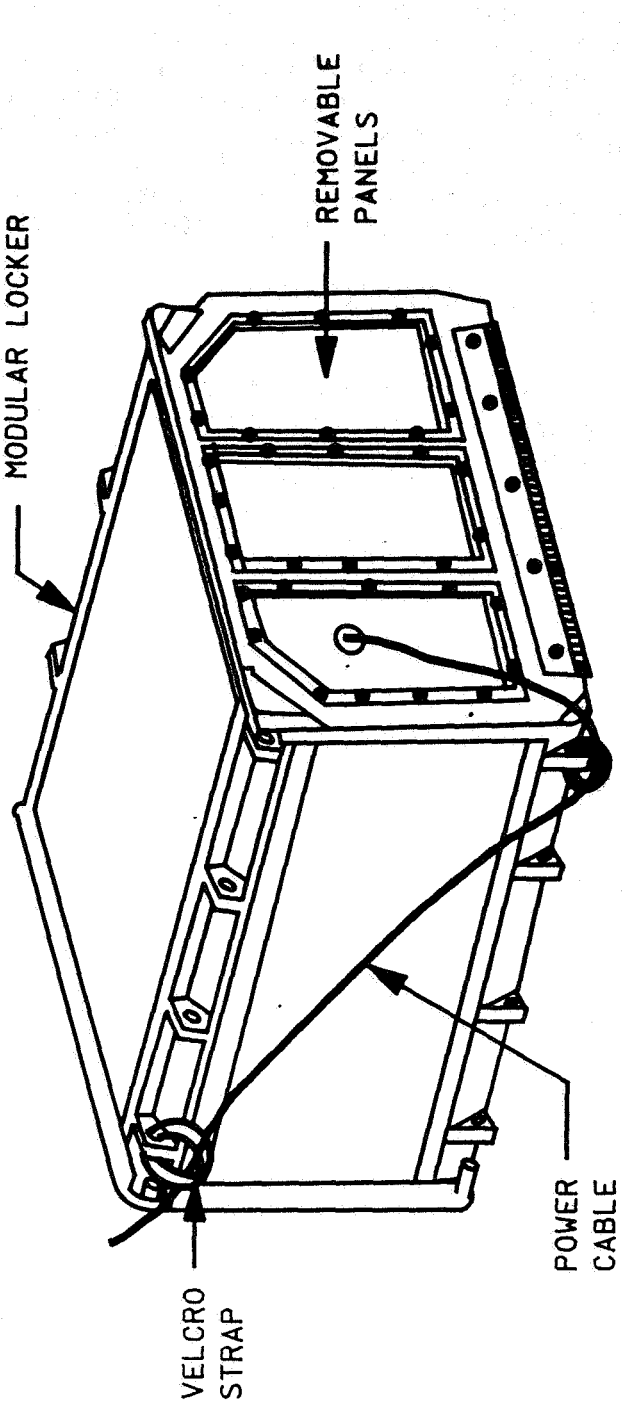


Figure 17.- Typical cable routing into locker.

3351.ART;2

3.5.1 DC cables - DC cables, which route DC power from spacecraft utility outlets to most stowage locations, are available for experimenter use. Each cable contains two conductor wires with a chassis ground and two plugs, one with pins and the other a socket (see fig. 18). The plug with pins mates with the Orbiter utility power receptacle with a socket, and the plug with a socket mates with the receptacle with pins on the payload/experiment. The DC pin plug used on each cable is identified by part number NB6GE14-12PNT2. The cable DC socket plug part number is NB6GE14-12SNT2. Connector part numbers and corresponding manufacturer identification numbers are delineated in Marshall Space Flight Center (MSFC) Specification 40M39569, Rev. D.

The drawing number of the DC cables is V733-718701.

3.5.2 AC cables - AC cables, for routing AC power from utility outlets to most stowage locations, are available for experimenter use. Each cable contains four conductor wires with a chassis ground and two plugs, one with pins and the other a socket (see fig. 18). The pin plug mates with the Orbiter utility power socket receptacle, and the socket plug mates with pin receptacle on the payload/experiment. The AC plugs with pins used on these cables are identified by part number NB6GE12-10PNT2. The AC socket plug part number is NB6GE12-10SNT2. Connector part numbers and corresponding manufacturer identification numbers are delineated in MSFC Specification 40M39569, Rev. D.

The drawing number of the AC cables is V733-718702.

3.5.3 Loose connectors - Experimenters are expected to provide their connector hardware. The experimenters are advised that a long lead time is required to purchase these connectors. A limited supply of pin receptacles, both AC and DC, have been stocked by JSC to support payload developers as an optional service. The AC pin receptacle part number is NBOE14-12PNT2. Connector backshells, with either straight or 90-degree angles, are also available in limited quantity.

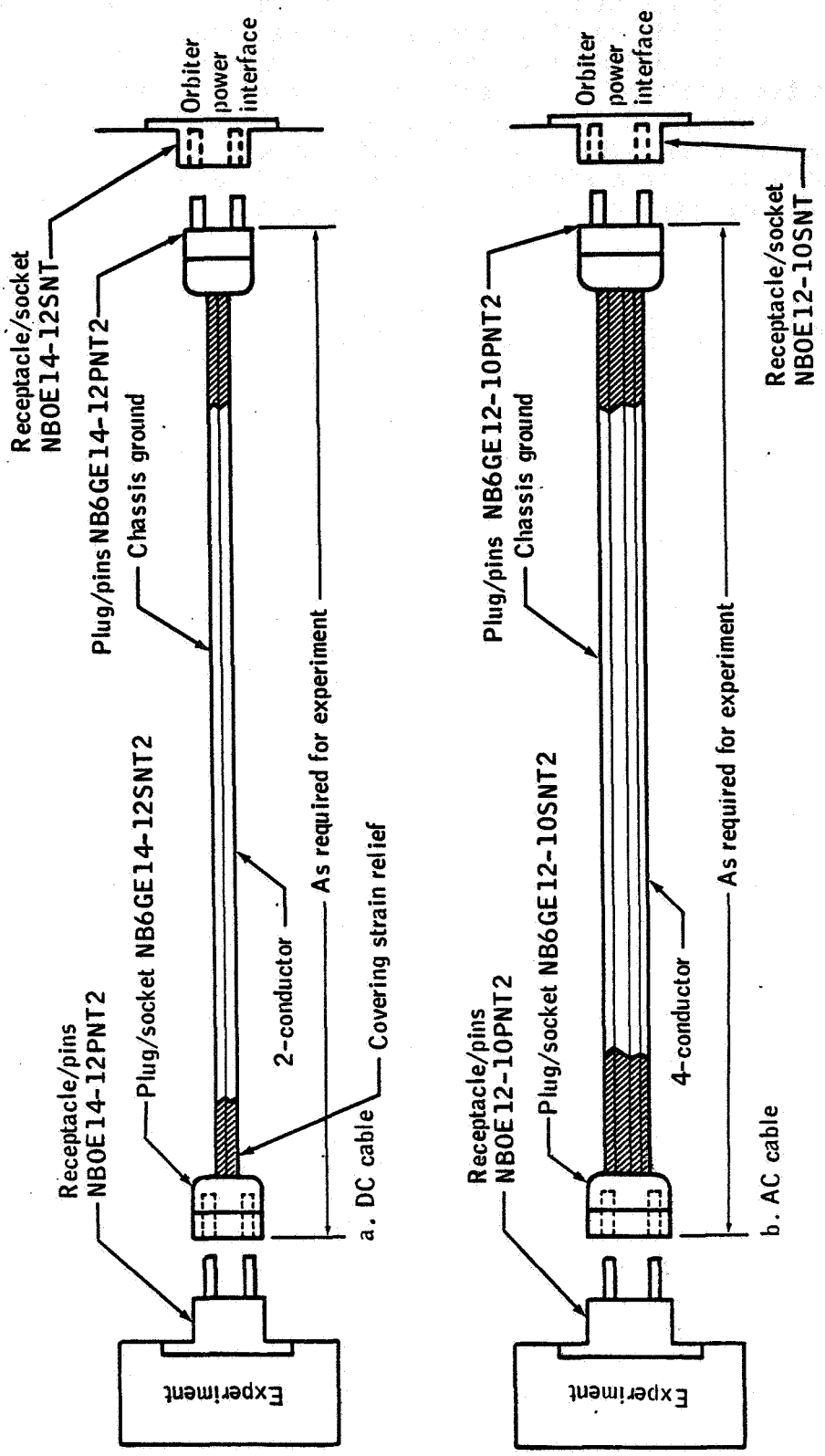


Figure 18.- Diagrams of DC and AC cables.

3.6 GROUND SUPPORT EQUIPMENT (GSE)

Ground handling of hardware without handles, particularly if the items are heavy and bulky, becomes difficult if the items must be stowed at the launch pad. To facilitate this handling process, GSE receptacles (PN MD-122-0012-004) and rivets (PN NAS 1198-4-4) should be incorporated in the user's hardware. A limited supply of GSE receptacles has been stocked by JSC to support payload developers as an optional service. These receptacles, shown in figure 19, can be used either with a T-handle or with a single handle. It should be noted that for a single handle, the receptacles must be accurately spaced on the experiment hardware. See handle configuration in figure 19.

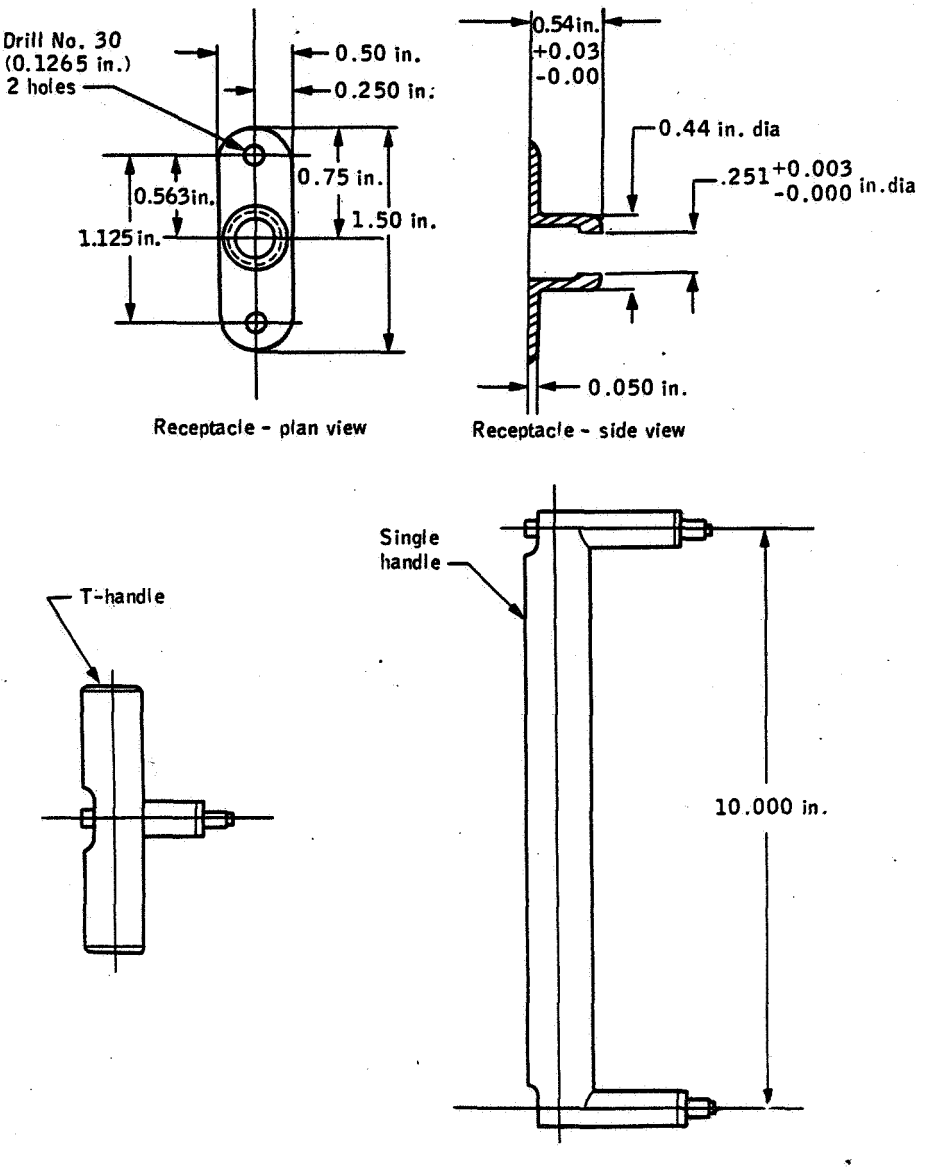


Figure 19.- Quick-release receptacles and handles.

4.0 EXPERIMENT HARDWARE CONSIDERATIONS

The experimenter should be aware of several hardware design constraints relative to crew safety. Of particular importance is the selection of materials compatible with crew compartment habitability. For details the NASA materials specifications NHB 8060.1A and SE-R-0006B and the Safety, Reliability, Maintainability, and Quality Provisions for the Space Shuttle Program (NHB 5300.4 (1D-2) should be consulted.

The Interface Control Document (ICD-2-1M001) which delineates the criteria for integrating payloads into the middeck has been added to the program. This is a controlled document and users are directed to this document, in particular, for the requirements that must be met for payload integration.

The experimenter will use the Crew Compartment Annex (Annex 6) to the Payload Integration Plan to list requirements relative to hardware handling. These requirements may include vibration protection, launch loading time lines, experiment stowage location and orientation, postflight disposition, flight crew involvement, and crew training on unique hardware operations.

The experimenter is responsible for delivering flight-qualified hardware to the appropriate bonded storage facility in support of Orbiter launch schedules. In some cases, a payload may be designed to replace a stowage locker, but only when the payload supplier can show that their package cannot be designed to be accommodated in a stowage locker or on an adapter plate. For these cases, stowage accommodations will be worked on a case-by-case basis and the payload supplier will meet the structure and loads criteria for the lockers. This criteria can be found in Rockwell specification number SD77-SH-01178, pages 7.5.3.1, 2 and 3. It is imperative that further approval be given by the JSC Structure and Mechanics Division before final integration of hardware is done.

5.0 REFERENCES

The following reference material may be useful in developing payload hardware. These documents may be obtained through the JSC Shuttle Information Service at the Documentation Management Office.

Space Shuttle Payload Accommodations

- JSC 07700, Vol. XIV (Interface Control Document 2-19001)

Crew Station Specifications

- JSC 97387A

Electrical Connector Specification

- MSFC 40M39569, Rev. D

Flammability, Odor, and Offgassing Requirements

- NASA Handbook 8060.1A
- SE-R-0006B

Manned Spacecraft Criteria and Standards

- JSC Manual 8080

Orbiter Vehicle End Item Specification

- Rockwell MJ070-0001-1B

Data Requirements for the Orbiter Crew Compartment

- JSC 14095 (Annex 6)

Safety, Reliability, Maintainability, and Quality Provisions for the Space Shuttle Program

- NASA Handbook 5300.4 (ID-2)
- NASA Handbook 1700.7

Environmental Requirements and Test Criteria for Orbiter Vehicles

- Rockwell MF0004-014

Orbiter Middeck/Payload Standard Interfaces

- ICD-2-1M001

Shuttle/Payload Standard Integration Plan for Middeck-Type Payloads

- JSC-14084

ORBITER MIDDECK PAYLOAD PROVISION HANDBOOK

Standard Distribution

JSC
AE/Aaron Cohen
CH3/Richard W. Nygren
DG/James Blodeau
DG3/Renato D. Dell'Osso
EC3/Fred McAllister
SP/Don Travis
SP33/Marion W. Hix (50)
ER1/Francis J. Devos
ER1/Helmet Kuehnel
ES2/Ben Holder
ES2/George Sandars
SP/Chris Perner
LA6/Leonard Nicholson
LM/R. E. Matthews
LM/Al Bishop
LP/Charles Chassay
LP/Paul Jaschke
LT/Richard Hautamaki
JM86/Remainder (30)
MA/Arnold Aldrich
SE/William H. Bush
SE/Robert S. Clark
SE5/Pat Bahr
EX11/William J. Huffstetler (3)
MF12/Jerry Goodman
LN/Larry Bell

Ames Research Center
240A-3/Annette Laboy (5)

Goddard Space Flight Center
420/J. Busse (5)
804.1/A. T. Dannessa (10)

Langley Research Center
158/F. Allamby (5)

Lewis Research Center
501-7/W. Hawersaat (5)

Rockwell Downey
MR4/H. Peck - NASA SSPRO
Attn: AA36
AC92/Mary Perfard
AC25/P. Soldano
AC25/K. Shaw (2)

NASA Headquarters
MC-1/C. M. Lee (2)
MC-6/B. Green
EM-8/Garland Misener (100)

KSC-FLA 32899
ZK25/Tec Data
VT-OOO-2B/C. Spern (2)
NWSI-D/Repository (20)

MSFC-AL 35912
JA21/R. E. Valentine (5)
EEL15/Billy Nunley
JA71/C. Sprinkle
JA31/Jerry Hawkins (2)
EL52/Nelson Parker
AS24D/MSFC Repository (10)

JPL-CA 91109
Dan Kerrisk
Charles Youngberg
Robert Lee Robinson

Vandenberg AFB-CA 93438
DO20G/DOO STS Data
Depository (10)
P.O. Box 1681

Singer Link - Houston
286/M. Whelton